

ABSTRACT

The present invention provides fully tunable photonic band gap (PBG) materials. These materials are periodic composite materials comprising a high refractive index dielectric material and another optically anisotropic, birefringent, electro-optically tunable, or magneto-optically tunable material with a lower dielectric constant in which the photonic band structure can be globally or locally changed in a controlled manner by application of an external electric, magnetic, or electromagnetic field, whereby changing the refractive index properties of one or more of the dielectric constituents by application of the field modulates the photonic band structure. In one aspect of the invention, when an optically birefringent nematic liquid crystal is infiltrated into the void regions of full bandgap (PBG) material based on an inverse opal, the resulting composite material exhibits a completely tunable PBG. In particular, the three-dimensional PBG can be completely opened or closed by applying an electric field which rotates the axis of the nematic molecules relative to the inverse opal backbone. Tunable light localization effects may be realized by controlling the orientational disorder in the nematic.